DR H. DAVIES
ON
"THE CEREBELLUM."

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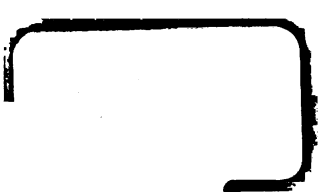

"THE CEREBELLUM."

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PREFACE.

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This Lecture is published at the special request of numerous Surgeons who have been so kind as to refer to me special cases that have occurred in their regular practices.

The fact that the distribution of this publication could not well be restricted, has necessitated a summary of the results of xperiments rather than iteration of them severally.

The information advanced is, of necessity, fragmentary, but it has taken years to cull, and if it tend but slightly to contribute to the elucidation of the important matter of Cerebellum Function, I shall feel more than repaid for the labour it has involved.

Barnes, 1898.

"THE CEREBELLUM."

The whole of the Nervous System, including the sympathetic and peripheral nerves, as also various epithelia and structures,—are derived from the first of the three blastodermic layers,—the Epiblast, Mesoblast, and Hypoblast, with which the student of embryology has to become so familiarized. The study of the development of the brain is replete with exceeding interest and charm, and the reward of the diligent inquirer who, commencing at the pre-natal state, recognizes the primitive changes and follows them onward with a growing wonder and increasing apprehension of their eventual modifications and purposes, until the embryo, through all its stages, has been ushered into the light of life and traced progressively through an amazing complexity of relationships,—the reward of such an one is incapable of verbal expression; it is certainly most profound.

The principal reason why people who approach the study of the brain and its functions go away disappointed, discouraged, and appalled at the immensity of the subject, is because they allow themselves to be deluded in the first instance into a short but altogether wrong method of research. They begin at the wrong end and fondly hope they will be able to master the subject by taking somewhat of a retrospective view of its tenets, rather than a progressive one.

Briefly, the Cerebellum may be described as consisting of two hemispheres or lobes connected centrally by elongated processes termed Versiform. In addition to such connection, there is that of the middle crus – the greater portion of the Pons Varolii being included in it. The remaining adjacent connections are the superior and inferior crura; the former, with the Vieussens' Valve, forming a junction with it and the Cerebrum; the latter answering the same purpose with the Medulla Oblongata. In structure, the Cerebellum consists of grey and white matter,—the white being the internal, and the grey the external. The convolutions are not at all like those of the anterior brain or Cerebrum, and could not by any but the merest novice be confounded with them. Near the centre of the white substance of each Cerebellum lobe is found the corpus dentatum, a capsule not unlike that of the olivary body of the medulla, and easily recognized upon section through the left lateral part of the Pons. In addition to the corpora dentata there are two other grey nuclei, the roof nuclei of Stilling. These are beneath the central lobule of the superior vermiform process.

Microscopic examination of a specimen taken through the cortical part of the Cerebellum reveals:—1. Beneath the Pia Mater, a thickish layer of connective tissue containing numerous surface-ascending, fine-branching fibres termed the processes of the Purkinjé cells, also scattered roundish corpuscles. 2. A single layer of large branched nerve-cells, each with a large spherical nucleus containing a single descending process and many ascending branches extending into the external layer and becoming continuous with the corpuscles therein. 3. The granular—nuclear—layer, consisting of large numbers of neuroglia and other corpuscles, some quite small nerve-cells with minute ramificating terminations—one branch, in particular, extending to the molecular layer. 4. The nerve-fibre layer or arbor vitæ:—those bundles of nerve fibres usually spoken of

as the white brain matter because of their characteristic whitish appearance. They extend considerably, in some cases traceable as far as the Purkinjé cells, in others progressing into the molecular layer, thenceforth losing their medullas and dividing and subdividing as a consistence of the layer itself. Thus the molecular layer is rich in connections, for it contains fibres not only from the cells proper and from the nucleus and central grey matters, but from the Purkinjé cells also.

Now the Cerebellum presents three pairs of groups of white fibres,—one proceeding from the cerebrum, one from the medulla oblongata, and the other principaly transversely commissural. This last pair, familiarly known by the name of restiform bodies, are the inferior peduncles. The first pair, or superior peduncles, proceed almost entirely from the cerebral peduncle tegmentum. They pass to the convolutions via the corpora dentata and comprise the processus e cerebello ad testes with the intermediate Vieussens' valve. The second pair, or middle peduncles, consist mainly of the transverse fibres of the Pons but comprise also the cerebellar fibres derived from the crust of the cerebral peduncles.

The most direct and immediate communication between the cerebrum and cerebellum hemispheres is by decussating fibres originating in the cerebral ganglia which pass backward and ramificate in the imbedded ganglia of the white cerebellum substance. These fibres are severally derived from the crust and from the crura cerebri tegmentum. The cerebrum and the cerebellum combine in contributing fibres toward the formation of the medulla oblongata, continued in the one place from the layers of the crura cerebri, in the other from the restiform bodies.

The central lobe of the Cerebellum is the only part susceptible to irritation, and, inasmuch as it can be traumatically removed in section, one is not surprised

at finding, as a general rule, that sense disorder is not induced by the presence of cysts or disorganization during or following disease. If the contrary were the case, one would have to describe this part of the brain as a dominant organ of sensation. However, it is not until the crura are touched that pain is felt, and then it is of an acute order. Numerous experiments, the detail of which is rendered unnecessary by the knowledge that they were productive of like results to those obtained by other scientists, satisfy me that no cerebellum irritation directly produces movement, and yet, although irritation, of itself, is so futile of result, it is remarkable that partial excision causes most peculiar symptomatic phenomena. Superficial extirpation heralds a lassitude of exercise and irregularity of muscular action, a condition deepening into one of violent spasmic irritability proportioned to the depth of excision, and culminating in partial loss or derangement of capacity of locomotion and, sometimes, of complete loss when the entire part is removed or severed. The consciousness of threatening danger or of encouragement is undoubtedly retained, as evidenced by abortive attempts to secure avoidance or compliance; perception is, apparently, and, to my mind, conclusively—unimpaired, as, too, is the power to feel pain, but co-ordinative power is totally extinguished. Without a single exception, such were the results obtained by me, results as invariable with dogs as with cats and birds.

Bouillaud, Flourens, and others whose names and researches are familiar to all, inferred from like observations that co-ordination of movements was essentially a Cerebellum function. Remark here, that the word co-ordination is used and not the word origin. As such, it—the power of co-ordination,—is accessory and not principal. Traumatism and disease ally in confirmation of this view, though it must be added for accuracy's sake, that the support rendered by comparative anatomy is but very minor, and, at best,

questionable. Now one comes to a very important thing when one has to determine whether the Cerebellum can or cannot rightly have attributed to it the function just briefly described. The adjacent relationships of the cerebellum must be borne in mind, and this very remembrance must force one to hesitate in laying down or accepting such a sweeping hypothesis as is done by others respecting co-ordination. Is the Cerebellum not connected with the posterior columns of the cord as well as cerebellar tract, and are not these both media of muscular sensations? Further, is it not connected through the Pons with the efferent tracts from the several cerebral hemispheres? To both these questions the answer is—Yes. That it has auditory and optical connection is equally indisputable. The whole phase of this subject is most entrancing to the philosopher, the care must be that philosophy shall not be permitted to franchise its own orbit and be lost in nothingness. Personally, I am constrained to the belief that the sense essential to the action of will upon muscles, rather than the already stated hypothesis, is the one most in conformity with present evidences, reason, and, as it happens, least provocative of question of the phrenological determination of Cerebellum function. One might go further and say, in no way provocative.

Partial paralysis and disorganization of movement sequent upon the section of the corporae quadrigemina and striata, crura cerebri, medulla, and pons Varolii, as also the major cerebral lobes, are indications, examples of which are frequently seen, and the balance of left and right parts is perceived to be essential to the right ordering of movements. Division, excision or compression, left or right only, force disordered movements, the bodily parts opposite to that of the division, excision or compression being those evidencing most profoundly the muscular disturbances, and, in instances of circular rotation, such being outwards and away from the part. The brute world and humanity are

not unlike in their subservience to this rule. Exostoses and effusions being the usual causes of the phenomena when observed in human beings.

Very little is really known of the effects of castration upon the body and mind. Reasons for the paucity of information are not far to seek. There have, of course, been writers upon the subject, but probably no observer has remarked more cases than has Gall. There is an analogy between experiments upon animals and men, but I am not altogether assured that this analogy, of itself, warrants us in enunciating a premise, as there is so often the temptation to do, the acceptance of which entails so much. Further, the position that man occupies in the scheme of creation is so uniquely isolated psychologically, that the greatest discretion should be exercised ere we define a principle which may involve a sequence of conclusions of startling and novel nature. Analogy is of the utmost use to the student, yea, analogy is indispensable to reason, but one's analogy here must be permitted to be nothing other than contributory. Thus, reasoning must not assume the form of "Do radical operations upon the bodily members of the lower animals alone evidence a procreative cerebellum instinct?" The true form of one's thought must be rather "Do such measures upon the human being point in any way definitely to this conclusion?" To this may be supplemented, and, as purely supplementary it must carry weight, "What analogy can be made between results so obtained and those produced by operations upon animals."

This subject is essentially one for the advanced student, and one can expect none to fully grasp its magnitude, or what it involves, unless such an one be thoroughly cognizant of all the bodily processes. In order to rightly judge of castration evidences, a high degree of knowledge of Anatomy and Physiology is particularly necessary, for, without it, enquiry resolves itself more or less into the morbid, whereas, with it,

one is brought face to face with an engrossing and certainly very important phase of study. In cases of castration at prematurity, results are general and specific. The general being retrogressive and affecting the whole economy, there being an absence of bodily development except of a feminine description.

It is upon the evidences forthcoming of the influence of unilateral castration that one is inclined to place utmost dependence. Certainly after removal—a removal, by the bye, sometimes necessitated by disease—there is usually observed a shrinkage or substance modification of the opposite cerebellum lobe, with a corresponding cranial development. My experience upon this point has been, as far as human kind is concerned, limited to three cases. In each there has been occipital indications such as I have described. Absence of opportunity for extensive observation of the operative effect on man, has driven me to resource to members of the animal kingdom. The following analysis may speak for itself. It is of 38 cats, 14 dogs, 8 rabbits, 1 fox, and 1 monkey :—

Of 38 cats, 16 were killed within a week of operation.

11 showed slight opposite cerebellum diminution.

5 showed practically no opposite cerebellum or cranial diminution.

13 manifested a degree of softness on opposite cerebellum lobe distinct from the consistency of the other side.

3 were apparently normal, but one out of the three was markedly flat.

Of 22 killed from two months + after operation :—

19 showed exceptional diminution of opposite cerebellum lobe and slight cranial depression.

2 showed *increase* of opposite cerebellum lobe accompanied by exceeding softness and the

presence of much serous fluid of a fetid character.

1 was slightly shrunken and contained a small hard nodular cyst about the size of a small bean.

Of the 14 dogs. The first six experimented on were so small that, apart from there being increased softness of consistency, I was unable to give any weight to them in drawing my conclusions. The remaining 8 were dogs of large size; 2 were Boarhounds, 1 a Scotch collie and 2 Newfoundlands. These, with the exception of one of the boarhounds, were killed some time—from 7 weeks—after the operation. They all evidenced remarkably perceptible opposite cerebellum and cranial diminution, and the one boarhound killed on the 40th day after operation manifested a diminution of quite as great proportionate extent as those who were permitted to live longer.

The last 3 dogs were somewhat peculiar. One, a savage brute and a fierce fighter of all sorts and conditions of its kind, went mad, and had to be made away with two days after operation. On dissection I found the whole cerebellum excessively atrophied and the skull—occiput—thickened inwards and very friable. The remaining 2 dogs were Indian. Of these, one had unilateral paralysis supervene after the operation. It suffered no pain, but could not get about, and I thought it best on the third day to give it a final relief. The other dog had convulsions and died. In both cases I found distinct opposite cerebellum diminution and flatness, but no cranial depression.

My 8 rabbits were most consistent in results. They unexceptionally showed diminution of the opposite cerebellum lobes and, with two exceptions, corresponding cranial diminution.

The monkey was extremely young—too much so—and, if difference existed, it was very, very slight,—too little to be of note.

The fox, which after the operation seemed to lose much of its fierceness, showed very great flatness and smallness of the opposite cerebellum lobe.

The following very interesting case is one of unusual value. It was not an operative one, but a freak of nature. I refer to a prematurely born child (seven months), who had congenital unilateral absence (not an undescended case). This boy, now aged about 18, looks no more than ten. He has the size and general form of a young boy and he has, too, a small head. He is intellectually slow, but otherwise he is exceedingly cunning and deceptive, being as sharp as a needle, to use a well understood expression, and a consummate liar. He is cruel but not indolent, is full of animal life and spirits, but a perfect stranger to human passion. The cranium over the cerebellum on one side is very depressed and contracted. I might here state that the cerebellum diminution and accompanying cranial depression are greater when castration is pre-adolescent.

Speaking of Cranium shrinkage it is well to remark that such is much greater after castration in birds at the propagating period than at the quiescent.

For reasons it is unnecessary to state, one is precluded from entering into details of cases of external lesions and their effect on the human brain. It must suffice that 54 cases have come under my notice, lesions caused by accidents principally, but in several instances due to disease. Of these 54 cases, 46 had the cranial indication of flatness. The remaining cases showed no marked cranial differences and were externally normal; however, because such was so, in no way weakens the proposition that there was brain diminution and deterioration. My previous experiments had conclusively satisfied me that brain deterioration can take place independent of a corresponding cranial subsidence, though such would appear to be rare. I have observed four instances of

cerebellum injuries resulting in total loss of personal desire. One was a soldier and the remaining three workmen.

I have presented to the British Phrenological Association an occipital impression of the head of H. M. a male, aged 26, who had to undergo left unilateral castration on account ot a severe accident. One would have no difficulty in recognizing the considerable and rapid cranial shrinkage. The impression itself was taken thirteen weeks after the operation. There is a marked prominence on the one side, and depression on the other. Previous to the accident, and within an hour of its having happened, there was an equality and balance of outline.

No claim is made to having fathomed the whole subject of cerebellum function. Those instances have simply been investigated that have chanced to come under my notice, and I have endeavoured in an impartial manner to perceive any evidences for or against the theory that the Cerebellum plays not only an intimate, but an indispensable part in the particular function around which these statements concentre. That the conclusions I have arrived at are not anti-phrenological, may or may not be provocative of satisfaction and encouragement. That they are, in the main, calculated to strengthen one's conviction in the correctness of the phrenological explanation that the Cerebellum is the centre and seat of desire, I am inclined to subscribe. Needless to say, I do not infer by this, that the Cerebellum is restricted in its operations to this single function. That it is *not* so circumscribed it is unnecessary to do other than just state. Figuratively, like unto the electric battery, the Cerebellum is the generator of power in the special and important department now being considered, the nerves are but the conductors or transmitters, and the organs,—the bells, the ringing of which is not inherent but confluent.

I am not sure that it is not within my province to adduce the testimony of experience of ordinary individuals who have not been subject to radical operations, or met with accidents, and yet, who have been enabled to so order their conduct by applications, that, even the most erotic have been enabled to subjugate their besetting inclinations, and so, raise themselves, not only in the scale of morality, but to an altitude, intellectually, otherwise improbable of accomplishment.

Through no individual fault, we find many people around us shackled with hereditary and other taints, the tendencies of which act powerfully in dragging them lower and lower in the social scale. Oftentime, to our sorrow, do we remark the degradation of a life and example, that would, under different conditions, have proved useful, beneficial and ennobling.

Childhood is redundant with the pernicious fungus of wrong practices; youth and middle-age are by no means strangers to an elaborated lust; old age is so often shorn of its meed of reverence because of unnatural proneness and distortion of function. One must not close one's reason to the truth upon this matter. Many, who are what one terms bad and depraved, are so because their very birth, nature, and environment, have forced, with resistless strength, upon them, links that, when once riveted, have galled, and fretted, and weighed with increasing severity. Be one Rich or Poor, Christian or Confucian, Mahometan or Freethinker, or What-you-will, there is no man who is in any true sense human, who is not touched to the heart when brought face to face with instances of suffering, fallen, fellow creatures who have striven, yet, perchance, striven in failure, and, striving—have failed to rise above their lower desires. Our lunatic asylums abound with such, of whom it might be said "They fell—*not* because they strove not to rise, but because they were incapable of rising." This brings me to some secondary evidence corroborative of my designation of

cerebellum function in this matter, which, even if it stood alone and unbuttressed by any weightier truth, would of itself merit a glad welcome, for it directs whence the ill arises. Now, let it be supposed that the cerebellum be the seat of this function, should it not be naturally concluded, that, if the function be abnormal, then the cerebellum itself should merit treatment and not simply the organs dependent upon it? Let the supposition be carried still further. Still taking it for granted that the cerebellum is the seat of the function;—if we find that depressants applied to the external organs were unproductive of modification or cure from tendency, and yet depressants when applied over the region of the cerebellum *were invariably* productive of modification, and, even at times, of cure from unnatural tendency, what would be surmised? At least that here was a fact, a demonstrable truth. Even so! Then Phrenologists may henceforth rest them upon one rock that no storm will undermine or weaken; a rock, the stability of which is not evident only to the deeply learned, but one that can be made so to the poorest and most ignorant by the simple expedient of testing. Let me reverse my way of putting it, for lucidity's sake. If depressants fail when applied other than to the cerebellum region, to modify every inordinate case; if they invariably succeed when they *are* applied to the cerebellum region, can the most cautious aud bigoted do other than ascribe to that region, a direct, restrictive, vital and governing power?

The contentions of modern science have little in common with old ideas and the simple yet erroneous philosophies that, for so long time, were received as true, and acceptance of which was deemed above question. In those times, one is rather disposed to think, there was not much care exercised in distinguishing between the instrument and the origin of the force which the instrument evidenced. This being so, it is not so very surprising that the organs had attri-

buted to themselves the faculty of creation and dominance of organic function. The following two typical cases, where the old contention is immediately seen to be fallacious, may serve as examples:—

C. M. A male, aged 84, complained of an almost constant inclination, yet he was physically incapable, and specifically organically diseased. The recommendation of ice-bag application to the posterior region of the head proved of considerable temporary benefit. Leeches were also subsequently applied.

A. R. A male, aged 28, a well known soprano singer of foreign nationality, who had been sacrificed in order that there might be retention of a remarkable voice possessed by him when a child, suffered acutely at night-time in the absence of light, and when isolated from company. The only uncommon additional point of interest in this case was, that he had accompanying neuralgic pains. Applicatlons of ice, as before, were almost instantaneously beneficial. My immediate purpose is served or I would mention in detail several child cases where there has been manifest a strong and exceptional inclination that their state of very incomplete development has quite obviated being other than cerebral.

The Cerebellum is quite as susceptible to growth or deteriorative changes as the Cerebrum, and the same *method* of practice or process that causes the one, is capable of causing and actually does cause the other. In the Intellectual, growth follows concentration of thought, frequency of use, and contributory association In the Moral, likewise;—the degree, of course, depending upon the original state and development. A high or large natural or normal appearance of a cerebrum part, is the index by which may be gauged the strength of what may be termed inborn, or hereditary gift. To a person possessing such, there comes that readiness and ease of exercise and cultivation that would be

expected,—a very warrantable expectation, too. So also with the cerebellum and the function ascribed to it; size is as properly an indication of capacity of power, as size is an indication with the Cerebrum part. In speaking of size, the word is used in the triune sense of magnitude, comparative magnitude, and symmetry,—that is to say, size in itself, relative size in comparison with other parts, and size as qualified by distinct abnormality. That these three points can be determined from external examination, if it has ever been questioned, must have been so by those ignorant of anatomy,—in fact it is easy of accomplishment.

Now in respect to the determination of cerebellum size during life, I have not personally been confronted by any of the difficulties that have appeared so insuperable to many scientists. Upon this matter a great deal of controversy has been indulged in, controversy having—as controversy so frequently has—a misunderstanding of definitions as the basis. The position of the lower part of the vertical portion of the occipital spine, and the accompanying projection observable above the nape of the neck, was, at one time, and in certain quarters, even is now more or less generally believed to be the spot immediately beneath which is supposed to rest the cerebellum; but physiologists know right well that the prominence does but separate the cerebellum lobes, and serves in no way to conceal either the form or size of the cerebellum. It is observation of the arch found towards the posterior edge of the mastoid, formed by the inferior and posterior portion of the occipital bone, that affords a safe and uniform gauge, except in cases where osseous modifications and complications of a purely medical or surgical order have appeared,—but these are rare. In the normal individual, prominence or descent, or lateral extension of the arching,—mark largeness; contraction, flatness, depression, or narrowness,—mark the opposite.

As a guide in dissection, the following may be taken as standard (authoritative) weights of brain parts :—

	MALE.	FEMALE.
Brain	49½ oz., avoir.	44 oz., avoir.
Cerebrum ...	43 oz., 15 dr.	38 oz. 12 dr.
Cerebellum ...	5 oz. 4 dr.	4 oz. 12¼ dr.
Pons and Medulla Oblongata ...	15¾ dr.	1 oz. ¼ dr.
Spinal Cord ...	1 oz. 4 dr.	1 oz. 4 dr.

I cannot agree with the late Dr. Gall in his published statement, that, should we find a part of the brain answering to the cerebellum above the spinal marrow, without exception throughout the range of the vertebrata, this fact would be sufficient of itself to establish the assertion that the cerebellum is the organ of the instinct of perpetuation of the species. All Gall's arguments were not conclusive, nor could it be expected that they would be. This is one of the faulty ones. It is in the following remark that may be summed up a valuable and incontrovertible fact ;—*participants in copulation all have a cerebellum.* This is a diamond truth the light rays of which are distinct and constant. I have sought, energetically sought, yet sought in vain any other explanation of this co-incidence of connection between brain part and organic exercise. Now, it is the line of demarkation between what is organic and what is animal, or shall I say—what is bodily and what is neutral, or what is inherent or what is transmitted, that, if carefully drawn, will show the distinction between the conscious and unconscious, or cerebral dominated and that propagation which is—by demonstration—independent of cerebral governance. There are two great genera; the one, where the brain possesses sway and dictates ; the other, where continuance of reproduction is involuntary. It is well to remember, that, because fecundation has ensued and frequently

does so independent of *will*, this is neither proof nor contributory proof that it is accomplished independent of cerebral aid,—*Will* having never been claimed as a Cerebellum attribute.

I have been very surprised to observe the large number of people who still cling to the old idea that the generative parts are themselves the seat of sexual desire. I have never been able to satisfactorily account for this blind and unreasonable assumption. The lame explanation of their belief has been in the recognition that it is at the organ that the stimulus is received and experienced, but surely such a contention must be seen to be self-condemnatory to any impartial student. If one were to adopt the theory that coitus was the producer, and the organ the final seat of the stimulus, one would have to re-model all the accepted theories respecting the relationship of the brain with the bodily parts. Further, if the several generative parts were the seat of sexual desire, it would follow that diseased conditions of those parts would affect the desire of which they were the bases; but diseased conditions of the generative organs do not have this effect, and, whether the affection be one of ovarian dropsy, or venereal disorder, the utmost such conditions do, is to produce, or conduce to, organic irritation. In no case do they affect the desire in the way that has been supposed.

That there is a relationship between the brain and testes of a more intimate and peculiar nature than, say, there is between the brain and the hand, it requires no words to impress upon the reader. That the brain and body both depend upon the testes, more particularly at and about the period of puberty, is equally patent; but, because the testes are thus known to be indispensable to development in the male, is no warrant for the assumption, that, because of this,—because the body cannot fully develop without them,—because their loss depreciates the brain itself generally

as well as the body, they must possess the germ of origin and production. That the testes qualify development, and I am speaking more especially of the above period, is true; they do qualify development, and that, powerfully; in the same way, they qualify sexual action, but their disease or extirpation cannot be said to utterly destroy desire. As the regulators of its attainment, their absence prevents proper organic exercise, and, in this, their function is, metaphorically, equivalent to that of the bark of a tree. The roots of a tree gather, prepare, and propel the energizing sap upwards towards the tree extremities, but, if a circle of bark be cut from round the tree trunk, the tree-root energy is thence forward annulled. With the tree, the effect does not end though, at the stoppage of the sap progress; the root itself suffers and depreciates in a degree proportioned to the intimacy of the excision. This figure—crude as it is—may be applied to the question under consideration. The Brain exercises as real and vital an influence over organic exercise as does the tree-root over tree growth and sustenance. The fact that desire is retained after organic destruction or removal, is adequate proof that the desire has no abiding place or home in the organ. To apply the simile further, the brain suffers by organic removal just as the tree does by the destructive process already referred to. After genital organ removal, the brain part implicated as the immediate governor of the excised region, degenerates, depreciates, and atrophies.

Now, exercise is essential to health and contributes to growth, and there is no healthy growth without it. The brain centre depends vitally upon organic unity and use for not only a maintenance of its normal power but for extension of it. If one so operate upon the organ of action that that organ cannot act properly, its brain centre must deteriorate and be unable to carry out its function,—hence, in birds, the very inter-

esting changes in vocal development, and growth of head tufts at the season of excitation, and the accompanying brain and cranial enlargement, are phenomena that would not ensue were there organic destructions.

Comparatively speaking, the human cerebellum is a large organ, even when 'tis small. The fact that the generative action is initially sudden and not gradual, predisposes one to think that at puberty there is, apparently, an important cerebral as well as distinct organic stage in development. It is undoubted that Will has a strong power over the generative action, and, locating the generative function in the cerebellum, it follows that the cerebellum itself is subject largely, if not wholly, to the governance of the cerebrum. That this is so, is exemplified in some cases where the imaginative and other contributory faculties have been so considerable that they have influenced a small cerebellum to such an extent that it has attained an abnormal condition of exercise. The true test of the effect of largeness of the amative faculty, is the morbid thinking at odd moments, and the desire to exercise the act frequently. Perhaps the clearest evidence of the dominance of what may be called the Mind over this faculty, is obtained during the sleep of a patient; still, during wakefulness, heat and lasciviousness excite.

Now, in what way does dissection aid one? It satisfies that there is a distinct relationship between development, and size, and instinct. That is to say, from actual personal visual evidences, I affirm—First, that the Cerebellum has not acquired its full development, as so repeatedly contended, at the early age of two or three years. Second. Development is marked at adolescence. Third. The adult manifests still more evident development. Fourth. The aged show cerebellum diminution and contraction, and that, accompanied by osseous depreciation and thickening. Face to face with these conclusions,—each of which is not the result of isolated observation but multiple— how

can an enquirer do other than give them recognition? There is no Surgeon of observation with whom the appearances of skulls are not criteria of age. There is the truncated contracted cone-form cranial base of the child head, with its nearly adjacent mastoids; there is, later, the early widening of the latter and gradual depression of the occipital fossæ; the growing child shows a wide difference between the distances of the two mastoids and the two parietals; the adult has a nearer similitude of measurement; the aged show the thickened temporal. These may be said to synopsitize the principal points.

I give it for what it is worth, but comparison of numbers of the heads of birds and dogs killed during the quiescent and the propagating periods, has shown marked differences of size,—I am speaking, of course, of a particular region. The heads of those birds killed at the early part of the year being the larger. I have gone further than this, and have become enabled to fairly accurately state which of the two seasons has been the one during which a bird or dog has been killed. Familiarity with the general size of the bird or dog skull being one's best accessory. One might perchance deduce from this, the existence of a reciprocity of action between the brain and its adjacents, as well as between it and the objective of its influence—that is to say—its organ. I would commend to consideration this method of experiment,—the common house-sparrow being a ready subject, if not a willing. The experimental simplicity is such, that one's sense of size and form must be indeed small that fails to notice the differences.

In studying the relationship of brain with organ, it is necessary to start with a clear understanding of what we mean to be inferred when we use the word *sensations*. I should define such as the objectives resulting from stimulation of certain brain centres induced by the conduction thither, by the afferent nerves, of irritations.

Then it will be seen that a periphery, a conductor, and a receiver, are, under normal conditions, necessary. Such are supplied by the brain cell, the nerve, and the nerve receptive centre. We classify sensations under the heads of Common and Special ;—the Common embracing such as cannot be distinctly localized in one particular place, as,—bronchial irritation, visceral-fulness indication, thirst, fatigue, etc. Then there is the Sub-Common tactile sense, exemplified in burning, aching, tickling, etc. However it is not with Common sensations or sub-divisions of them that we are particularly interested. The Special sensations claim our closer attention ; i.e., Touch, Taste, Sight, Hearing, Smell.

It must be borne in mind that the seat of sensation is, by all physiologists, located in the brain, and not, as commonly and erroneously imagined by many, in the particular organ whence the sensory communication is received. The sensorium is in the brain, and, whether one be considering the eye, the ear, the tongue, or the sensory organ of generation, one recognizes the organs simply as receivers of impressions which are, by them, transmitted through their respective nerves to that particular brain part spoken of as the sensory seat or sensorium. What must be carefully remembered, is that sensations may be Subjective, and they may be Objective ; the difference between the two being great and vital. Habit and experience predispose us to refer all sensations to external (objective) causes, and it is exceedingly difficult to persuade oneself, in experience, that exciting causes can be other than objective. However, acquaintance with and observation of cases—of which there are many—that exemplify subjective sensations, will easily persuade that subjective sensations are not simply theoretically, but actually existent. The senses most frequently involved in subjective stimuli being those of sight, hearing and touch.

We would then refer subjective sensations to the category of Illusions. This brings one to the question of the causes of these subjective sensations. Congestion of the capillaries, a condition that may affect all the sensory nerves, is certainly one internal cause; the optic nerve apparently receives impressions of light, whereas no light is, in reality, in direct relationship to it; the auditory nerve apparently denotes a chaos of external noises, whereas no such chaos really exists; the olfactory nerve apparently makes one cognizant of odours that are not pervading the atmosphere; and the senses of taste and touch are no less susceptible to apparently external stimuli. Further, it is notable that one kind of sensation may be produced in two ways; objectively, as in the auditory apparatus, by sounds produced within hearing distance; subjectively, as by sounds that are non-existent externally but sensorily simulated by capillary congestion. However, this is but a general summary. One might proceed to evidence that the determination between subjective and objective sensations, is, at times, a matter of great difficulty. For instance, it would not be correct to say that the tinnitus aurium characteristic of many deaf people is produced by capillary congestion, although really no such noises are appreciable by the normal ear. I say it would not be correct to immediately infer that these sensations of sound were subjective,—it so happens that they are objective. Those who are acquainted with the principles of acoustics, know that sounds are modified, intensified, or depreciated, according to the relationships of the organ of sound, whether the relationships be those of the organ with its surroundings, or those of the organ with its several parts. Now, when the primary membrana tympani is partially or wholly destroyed, and the parts of the tympanic cavity have their offices interfered with, we know now that the vibrations entering by the meatus are modified by the tympanic cavity,—which serves as a compound

resonating chamber—in such degree, that the ordinary passage of air waves (not cognizant as sounds by the normal ear) induces an objective and real series of vibrations at the periphery of the organ of hearing.*

The effects of disease upon the senses are too numerous to tabulate. It is capable of demonstration, that, in health, the senses are subservient—under certain conditions—to mental governance, and that stimulation can be secured purely by the exercise of the imagination, will, or other faculties of the mind. I am not here referring to simply a concentration of the attention combined with the use of a sense, but to an exercise of the mind being provocative of sense excitation. The degree of organic activity does not depend upon its degree of susceptibility to sensation. This is an important fact. Organic activity, within the limits of its power, is directly and primarily subject to brain governance and regulation. Thus, the sensations of sexual desire have their sensorium in the brain, the desire being capable of spontaneous manifestation originally; capable, too, of external (objective) excitation;—but a desire, in itself, independent of the organ and immediately dependent upon its brain part. Any accomplishment of the climax of the sexual act apart from the presence of the sensorium must therefore be unaccompanied by sensation, desire being obliterated and sensations incapable of expression when their seat is removed.

Cerebellum Disease certainly causes a state of organic morbid excitement, but why should it?

Of course the establishment of a position in relation to this subject such as seems tenable, entails credence that cerebellum excitation—however produced—should increase genital activity, or, to be strictly accurate—proneness to activity, (for the organs may be incapable

* Vide the Author's "The operation of membrane excision, with prefatory remarks on Sound Conduction in relation to the Ear and Aural Surgery."

of the manifestation of activity and cause suspension of power when congested or atrophied). Now the remarks previously made respecting interference with the nervous connections between the cerebellum as the generator and the organ as the exerciser of power, are applicable here. Because others in their experiments, and I in mine, have observed numerous instances of extraordinary excitement of the sexual organs co-incident with spinal disease, is no warrant for a doubt that has been fully expressed somewhat in the following manner "We get organic excitement (sexual) of a high order when lesions other than those immediately connected with the cerebellum are present." A moment's reflection will prompt a further question that must replace it. "True, we get organic excitement of a high order when lesions are not immediately affecting the cerebellum, but do not such lesions interfere with the conduction from the cerebellum to its organs, and are not therefore these very lesions intimately related to the cerebellum, and do they not very vitally affect its capacity?" I fully expected, previous to embarking upon experiment for elucidation of the point respecting conduction interference, that such was inevitable, and, had it not proved so I should have had grave doubts as to the soundness of accepted definition of a nerve function.

The question of cerebellum disease can be dismissed in few words. Lesions are often attended by nystagmus and parallel optic axis deviation, loss of sight and hemiplegia, phenomena due to immediate involvement of neighbouring parts, to optic neuritis, or to abnormal pressure by the organ on the adjacent quadrigemina or medulla.

Hydatids are seldom to be found in the brain, and when they are there, they are usually found singly, though not always so. They are very curious growths of watery consistency, almost invariably barren, and sometimes attaining considerable size before causing

death. They have been remarked in the ventricles, subarachnoid tissue of the cord, affecting the meninges, and generally, embedded in the substance of the cerebral hemispheres. I have seen but one in that division of the nervous parenchyma which is now being studied. This measured 1⅝ in. in diameter. It was non-suppurative, and had caused, apparently, no surrounding inflammation.

Large Cerebellum development is accompanied by powerful manifestation of the amative propensity. I am, of course, understanding, now, that organs predispose to activity with a degree of intensity proportioned to their size—other things being equal.

Now, in mania we have the mental disorder invariably characterized according to the functions of the leading organs. Enquiry into details of many cases of insanity have, without exception, proved that whenever the cerebellum has been of excessive largeness, the main feature of the mental alienation has been one having direct reference to sexuality. Do not misunderstand me here, for I state rather a general than an invariable rule on this point, and it must not be forgotten that it happens—as instanced not infrequently in those opposite states of delirium and dementia,—that large organs may have, for a time at least, their powers held in check, whilst the morbid activity of a smaller organ holds temporary sway.

As far as I *do* go, I am anxious to be quite intelligible and clear, then let me state that whatever influences the Cerebellum has other than those I specify—and, I doubt not, it has others—I certainly ascribe to it the regulation of generative movements; I know no pathological evidences contradicting any of the statements contained in this book to the effect that Cerebellum action (sexual) is proportioned to its size; Cerebellum irritants induce organic excitement, whilst depressants reduce any that may be present, and, I might add that irritants, acting upon any of the nerve connections of

the Cerebellum with its organs, would also cause organic excitement.

Nervous tissue is composed of nerve cells and nerve fibres, the latter being extensions from the former—hence impressions that affect the one also affect the other. In the brain and other nervous system centres, these cells occur in great numbers, supported in substance variously termed neuroglia, reticulum, and polio-synectic tissue. The functions of the nerve cells and the nerve fibres are very distinct. The nerve cells receiving impressions and originating impulses, the nerve fibres conducting impressions to or from the cells and the periphery.

The Nerves are composed of protoplasm (proteid) and fat compounds, their chemical composition being of a very unstable nature. The mass of the brain is composed of protagon. It consists of lecithin, which contains phosphorus and cerebrin. The last named is a glucoside and the first and last are soluble in hot alcohol and ether. A greater quantity of water enters into the composition of the grey than of the white brain substance, there being 13·2 per cent more in the former. The proportions are 81·6 and 68·4 respectively. The grey brain matter, dried by gentle heating, yields 55·4 per cent albumin and glutin, 17·2 per cent lecithin (C_{42} H_{84} PN O_9 lecithin contains phosphorus and occurs in the brain mixed with oleophosphoric acid and cerebrin. It is found, too, in semen and white corpuscles—blood—in large quantities, and in smaller quantities in blood and bile. Treatment with various acids yields palmic, oleic, cholin and glycero-phosphoric acids). 18·7 per cent. cholesterin and fats, 1·5 per cent. parts salts. 6·7 per cent. is insoluble in ether. The white brain matter yields 24·7 per cent. albumin and glutin, 9·9 per cent. lecithin, 51·9 per cent. cholesterin and fats, 0·6 per cent. salts, and 3.3 per cent. extract insoluble in ether. Potassium and phosphoric acid are the principal constituents of the

salts. The albuminous compounds of nervous tissue somewhat resemble myosin, casein and a kind of globulin. The albuminoids are nuclein and neuro—keratin. The extractions include Kreatin, (C_4 H_9 N_3 O_2. Kreatin is a primary product of muscular disintegration. It decomposes in the blood into urea and sarcosin but does occasionally occur in urine. It is contained largely in muscle juice. Kreatin is converted into Kreatinin by treatment with hydrochloric acid or sulphuric acid) leucin, (C_6 H_{13} NO_2 amido-caproic acid or leucin can be prepared by boiling any of the gelatins with sulphuric acid. It occurs, too, out of the products of pancreatic digestion of proteids. It is found in many of the bodily organs and is found in urine in certain diseases. It occurs in crystalline form and as oily discs) lactic acid, (C_5 H_8 O_3) &c. *Note.*—The chemical constitution of Cerebrin is not known. It is light, shapeless, tasteless, and odourless. It swells when boiled. It is found in the brain, nerves, and pus corpuscles.

Nervous Tissue at rest has a neutral or very feebly alkaline reaction. It acidifies after excitation or death, a change due to lactic acid formation. Nerves are inelastic and possess but small cohesive power except when forming nerve cords by being bound by connective tissue. On account of the unstable nature of nerve tissue, its decomposition is readily caused by the sudden application of stimuli, which, by altering the composition of the substance of the cell, liberate force. Stimulus application must be sudden to ensure excitation, as if graduated progressively and slowly, it destroys the nerve without appreciably inducing activity.

The following is a list of stimuli:—1. Mechanical, 2. Chemical, 3. Electric, 4. Thermic, 5. Cell transmitted, 6. Cerebral.

There are several kinds of mechanical stimuli, including puncture, incision, division, slight compression

or traction, friction, blows. The smallest perceivable mechanical stimulus is that experienced from the blow produced by the fall of 900 milligrammes a distance of a single millimeter. Stimuli acting on sensory nerves originate impulses that proceed centripetally along different nerves, and produce characteristic sensations that enable one to deduce cause, and location where the cause acted. Stimuli acting on motor nerves induce like impulses, which cause either muscular contraction or gland secretion according to whither they are distributed. Excitation produced in a motor nerve is lost sooner than that produced in *a sensory nerve.*

Chemical stimuli act more readily on motor than on sensory nerves. Chloride of Sodium (ordinary salt) acts only on the motor nerves. Free acids, when strong (except phosphoric) act vigorously, as do weak alkalies, and some of the salts of the heavy metals, and many organic acids. Tannic acid does not act upon nerve. Dilute alcohol, ether, chloroform, and sugar, usually produce convulsions, and eventually cause the death of the nerves. Dilute alkaline solutions, after having increased excitability, depress it. Lime water, carbolic acid, and carbon bisulphide kill nerve.

Sudden application of electric currents is alone provocative of stimulus unless there be great increase or diminution of intensity. Electric currents may be constant, or induced (interrupted). The constant induces contraction when applied to motor nerves only at the making or the breaking of the current. When applied to sensory nerves, excitation is greatest at the making and breaking of the current, but is present during the intermediate stage. Increased effect is obtained on applying the nerve currents near to the nerve centres than when applying them near the periphery. Some nerves are particularly subject to electric stimulus. Nerve tissue is certainly more responsive

than is muscle to feeble electric currents, Of course, currents must be applied longitudinally to produce contraction. If applied transversely, the effect is practically nil. Induced currents are of great tension when established on breaking of currents, and continue in the same direction as the currents. The induced currents are very feeble, more slowly produced, and run in a reverse direction when established on making contact. With equal strength of the inducing current, the induced current established on breaking contact constitutes a considerably stronger stimulus than that established on making contact. Maximum stimulus is invariably produced at the cathode (negative pole). By applying induced currents to a motor nerve and commencing with those of feeble intensity, contraction first occurs with the induced current that is established on breaking contact, but, as the current increases in force, contraction occurs, too, on closing. This being so, each current interruption induces a double shock which tends to become more equal in force as the current is still further increased. Kathodic closure is probably a better expression than ariodic break.

Nerve paralysis may be caused by disease involving the nuclei or the nerves shortly after their offspring from them. It may too, and frequently is, found affecting those parts above the originating nerve nuclei. Thus when such parts as the pons, or medulla oblongata or brain base are affected, any resulting paralysis is likely to be compounded of paralysis due to the severance or interference with the proper communication between the higher centres and the nerve nuclei, and of that which is the result of immediate involvement of nerve cells. When a nerve is destroyed, the induced paralysis is of but limited extent; and so, also, when the original nerve nucleus itself is destroyed, and, what is more, it has a disposition to become determinate, or permanent, or absolute;—such absolute nullity of power being accompanied by a gradual irresponsiveness of the

muscular part or parts originally within the sphere of its influence. It would be expected that nerve nucleus destruction would cause these phenomena, and though there are certain other varieties of absolute paralysis there are usually found to be also certain nerves which are but partially involved or deranged and some not even implicated.

That imagination is capable of and actually does cause nervous stimulation is well known. With the exception of this, the whole of the aforementioned stimuli are capable of producing nervous action independent of cerebral aid (mind assistance). I am not alluding to the various sense deceptions, and what are ordinarily understood as hallucinations, when I refer to imagination stimulus, for it is an open question whether the nerves connecting a certain part with the brain really are stimulated upon such occasions or not; for instance, it is no uncommon thing to find people who are suffering from some form of mental alienation, who act and speak as if they were suffering from some kind of bodily torture. Such patients, whether their eyes be open or not, will cry out, at times, as if in great agony, when not even touched upon the susceptible part or parts; and, in like manner and just the same degree will they complain when really touched upon such part or parts. The debatable point is whether there is disorganization at the nervous centre of communication with the affected area, with involvement of the nerves communicating, or, whether the whole effect is cerebral. Of course there are sensory hallucinations which can unhesitatingly be referred to the brain, and which cannot—in the present state of our knowledge—be designated nerve stimulating. On the other hand, it is very clear that the faculty of imagination (allied) is capable of inducing nervous action, at any rate, of some bodily parts. That it does so, is evidenced externally, and, in the case of the generative organs, very markedly. The conjuring up of some erotic vision

often induces an immediate organic excitability, demonstrating so far in this particular, that ideas sexual have material effect in contributing to encouragement and imparting stimulus to the natural instinct. Of course I do not say that imagination is at all essential to the generative action; it is not, but, when exercised, it certainly modifies it, and—which is all I desire to substantiate at this point—it can act as a definite stimulant,—in which case it merits a place with the other nerve stimuli.

We know that muscles have an inherent property of contractility, and that when separated from the nervous system, and their connections thereto divided, they are capable of stimulation as long as their tissues are properly nourished. The nerve connections, then, are the media of a provocative by nerve impulse. It is plain that the so-called voluntary muscles of the body are subject to mental governance to a degree proportioned to their several capacities. The only difference between the voluntary and involuntary systems being, that one is subject to conscious will, whilst the other is independent of it. It is quite unnecessary for me to exemplify each. It has been advanced, but very illogically so, that the absence of conscious will subservience of the involuntary muscles obviates our reasonably classing them as cerebral dominated. I am not only assured that both the voluntary and involuntary systems are directly subject to and dependent upon cerebral governance, but that all the bodily functions come within the sphere of its connection, and, just as truly as there are brain regions or centres from which emanate the impulses necessary for the due stimulus of voluntary muscles, so truly, verily, are there brain centres or regions which give forth their own particular and restricted impulses, such impulses having connections with the whole economy and all the organs of the body, voluntary, and involuntary systems. Just as there is a particular brain region dominating a leg

muscle, so there are—though they may not yet have been located—stomach, lung, kidney, and other centres.

It is clear that the brain influences the whole of the muscles, and it is evident that the muscles of locomotion are in connection at any rate with the cerebellum. It is not necessary to adduce evidence to buttress this statement,—I am not aware that it is disputed. The recognition of the cerebellum as the procreative centre would be endangered were it found that there was not such connection; hence, the presence of such connection is a subsidiary link of some little importance. One would expect some muscular disorganization from radical interference with the cerebellum, though, as is known, the isolated cerebellum has no competence to cause muscular movements. That it may originate and yet induce the brain to regulate muscular movements, is within the bounds of reason. It is unreasonable to deny, in the present state of research, that the direction of generative movements and positions is exercised by the cerebellum, notwithstanding that other brain acquiescence and association are usually observed therewith.

One is too well cognizant of the result of excessive exercise of this propensity. The evils of excess stamp themselves upon the entire organization,—intellectual vigour and muscular power becoming impaired. There are the flabby flesh and listless appearance, the weakened heart and impaired digestion, the nervous tremor and stooping gait, the tell-tale pallid face and characteristic eyes, the invariable depreciation of those faculties that are antagonistic to the generative action—such as acquisitiveness and approbation—and distortion of contributory faculties—of which ideality is the principal. There is one thing in this connection that I have had abundant opportunities of observing, and it has been very general:—sexual excess has always preceded a heavy, dull feeling within that region of the cranium where is situated the cerebellum. If ordinary

headache—frontal—and backache be present, they may be described as purely sympathetic, and are not to be compared with the cerebellum pain for intensity or continuity. In hundreds of cases has complaint been made of this kind of headache, so much so that it is spoken of as the characteristic of debility. I prefer to term it cerebellum shock. When this shock is present, there usually is also a craning backward or falling of the occiput between the shoulders, as if that part of the head were too heavy to be carried erect and properly balanced.

On the hypothesis that rational exercise strengthens and maintains a normal development, continuance of the generative action is warranted, yea, essential. There is no doubt that complete obviation of the gratification of this sense causes a considerable disappearance of the desire, as has been repeatedly witnessed in instances of castration, and that the preservation of normal volume is dependent upon normal exercise, is equally clear. The evils of excess are too well surmised, and, if they were as well known, one would be brought in contact with fewer examples of depravity, with its accompanying loathsomeness of disease and degradation and abasement of body and mind. It would be well, though, if sufferers were to realise as fully as they may do, that, according to this same principle of exercise and resulting power, every succeeding occasion upon which the animal craving is subjugated and resisted, so much the greater is their resulting will dominant over it, and just as much the weaker does the natural desire become. It is because one is so persuaded of this that one hopefully recommends the strongest exercise of individual will, a will that may be strengthened in its weakness over a large Cerebellum organ by external depressants. Verily in such a matter the subjugation of self is one's hardest battle.

A great number of the Insane suffer from what may

be called in mild parlance, the Immorality of Insanity. Of these, many are abnormal people, possessing abnormal brains and addicted to abnormal practices. The subject of the treatment of lunatics is one of the most important, and remedial measures based upon reasonable principles should be introduced into practice. There should be recognition of the fact that mere isolation and confinement of the insane is quite useless to provoke either cure or modification of tendency. Careful confinement and constant supervision is, of course, most necessary as a general rule, and it is not to be inferred that this should be discontinued. However, most emphatically is a practice of confinement to be deplored when nothing is attempted to restore to the afflicted at least some measure of a return of that balance of mind which is indispensable to a right estimate of life and its responsibilities. A sufficient study has not been given to this phase of Insanity, and the result is seen in an apathy of treatment, a laxity of resource, and a fruitlessness of result. It is quite certain that medicine is no cure for madness, nor is rigid discipline. Methinks there is no sadder sight in this strange yet beautiful world, than the picture presented by a human being, bereft of reason, and a prey to some repulsive, abhorrent freak of mental and physical distortion of function. With health, with strength, and with courage and mental poise, life is intensely earnest, but what shall be said of life when one, who has it, is suffering from that piteous curse, which not only robs life of all that is dear and pure to the sufferer, but projects into the lives of others a shadow, a discord, and a contradiction that seems to find no other equivalent in the whole history of human misery and suffering. Insanity not only deserves study, it demands it with authoritative voice, and to none does it appeal with greater force, than to him who is making inquiry and research into the engrossing subject of mind.

The question is often asked "Does desire exist when there is no remaining capacity for its gratification?" It does, and I have known numbers of instances of it so existing. The following is one chosen quite at hazard from my note book: R. L. M. male, aged 28, a most immoral person, and one who had given way to the vice in any and every form, presented himself suffering from nervous and physical prostration. His intellectual faculties were dulled, and, though he was strongly built and generally healthy, he was quite unable to secure by any means organic excitement. The organs remained thoroughly lax and dormant. He, nevertheless, complained of an exceedingly powerful inclination, and, at times, the desire was so strong that he quite babbled in an incoherent manner and endeavoured for sometimes an hour at a time to induce bodily enervation, but failed to attain his object. There were periods of intermission from these heats, but they were of short duration. The usual treatment I have previously indicated, was eventually successful in ameliorating the inordinate degree of desire, but it recurred at irregular intervals.

The question of Posture, as indicative of the seat whence desire springs, is one that, though purely subsidiary, is not unworthy of a presumptive place in the aggregate of evidences it is our duty to tabulate. As far as scientific value is concerned, it must not be imagined for a moment that we unduly estimate it, still, I know no reason why we should refuse to apportion it any weight at all. To say the least, it is surely a strange thing that nearly the whole of the vertebrata evidence by characteristic postures and gestures their possession of excitation, and more strange still is it, that there is an unanimity in direction, an unanimity that points as clearly as we could wish to the cerebellum as the centre whence floweth that mysterious spring of desire which has so much to do in the fashioning of life and character, and in conducing to happiness or

misery, health or degeneracy. Look where we will, can we shake off the conviction that around us are million mute monitors instructing us to one conclusion and one only? The animals, wild and untutored, or gentle and almost human in intelligence; the birds, fierce and voracious or timorous and weak, sweet-voiced or well-nigh silent; and lastly, human kind itself, from the highest in degree to the lowest—all range themselves on an equality here, and, of them all it can be said

> All face towards a goal—one goal—
> And that the only possible of reach,
> Directed thither by an unseen Hand
> That's mightier in that, though unseen,
> It forces to a mute obedience.

Every desire, every passion, springs, either spontaneously or by excitation, from the brain. The brain is the home of desire. Its excitants may be legion and they may be connected from remote or near areas. It has, I know, been denied that the mind ever plays any part in excitation of feelings. It has, too, been denied that the world is of an oblate spheroidal shape. Independent—totally independent—of outside influences, the manifestation of exercise and dominance is observable on every hand. I recall to my mind now an instance in which cerebral trouble in typhus fever in a man induced an unnatural and constant indication of excitation.

The size, shape, and position of the cerebellum differ very considerably in the various vertebrated animals, so that it is no easy matter to express opinions as to its exact character of extent without an anatomical acquaintance with the various animal classes. In man, we have the cerebellum consisting of two major lobes with central attachment process. In birds, we observe the semi hoop-series formation with gradual diminution from the centre outwards. In reptiles, we observe what may be advisedly called the intermediate formation of cerebellum. It is worthy of passing remark, that

reptile, bird and fish cerebella are single, whilst those of the mammiferæ are double. The size and appearance of the Vermiform process differs in many animals, as does its proportion compared with the other brain parts. The fact of its largeness in climbing animals has led to the supposition that it bears a relationship to their ability as climbers, however, whether this be so or not, I am unable to do other than conjecture.

It must not be supposed that it is a matter of comparatively little difficulty to make observations respecting the lower animals, for it is not so. The knowledge of the exact situation of the cerebella in their skulls is indispensable, and this is not acquired without much practice. In those species members of which never walk erect, as for instance, the tiger, the cerebellum is almost unexceptionally horizontal and, for the major part, behind the brain. Degrees of development in such are determined by examination of those parts of the skull immediately above and to the left and right of the basal occipital aperture. It can thus be seen that animals of the tiger class, and others that come under the above mentioned category, must have a different manner of observation applied, and, necessarily, different judgment, in order that an accurate designation of degree can be arrived at. It is easy to perceive then, that the tiger's cerebellum has relationships that are quite distinct from those of man, for we know that the cerebellum of man, and, I might add, generally speaking, the cerebella also of erect animals, are more or less covered by the posterior portions of the brain; hence, for determination of size, one is restricted to examination of the basal posterior portion. Coming to the bird kingdom, the cerebellum is found practically answering to the vermiform process, occupying the central part of the occipital bone, and extending from the middle posterior region of the two brain hemispheres. The contrasting of these middle portions of birds' heads is of valuable assistance in helping one

to determine bird sex,—the male birds' having a greater size and rotundity. I found this so in 132 birds. (9 cocks, 28 hens, 16 turkey hens, 19 turkey cocks, 17 ducks, 5 drakes, 26 partridge hens, 12 partridge cocks.)

The following table of the Vertebrata has an asterisk prefixed to each class, members of which I have experimented upon with a view to the determination of cerebellum function :—

VERTEBRATA.

MAMMALIA.

Monodelphia.	*Representatives.*
*Primates	man, monkey, &c.
*Cheiroptera	cat.
*Insectivora	hedgehog.
*Carnivora	cat, dog, &c.
Proboscidea	elephant.
Hyracoidea	hyrox.
*Ungulata	horse, sheep, &c.
Sirenia	dugong.
Cetacea	whale.
*Rodentia	mouse, rat, rabbit.
Edentata	armadillo.
Didelphia	kangaroo.
Ornithodelphia	ornithorynchus or duck-billed platypus.

AVES.

*Carinatæ	fowl, duck, swan, &c.
Ratitæ	ostrich.

REPTILIA.

	Crocodilia - -	crocodile.
a	*Ophidia - -	snake.
	*Chelonia - -	tortoise.
	*Lacertilia - -	lizard.

AMPHIBIA.

	*Anura - - -	frog.
	Urodela - -	newt.

*PISCES - - - cod.

NOTE *a*. Viper (Coluber berus) Black Viper (Coluber prester) Rattlesnake (Coluber naja, crotalus horridus, cobra de capella) Indian Serpents (Coluber carinatus, Katuka Kekula Poda, Rodroo Pam) English Viper.

There are certain diseases that have caused a great deal of conjecture as to whether or not the brain centres have really undergone changes during their progress and directly attributable to their deteriorative influences. I refer especially to Hydrophobia, a disease due to the introduction into the system of a poison existing in the saliva of rabid dogs, wolves, foxes, hyenas, cats, and, occasionally, goats and sheep. There are numberless surmises, but no definite knowledge extant, as to the cause of the origin of Hydrophobia. It is frequently said that the intense heat of the "dog days," or severe cold, or want of water, or domestic training and the physical deterioration thereby induced, may be considered principal causes. However, opinion is very varied, and, though probably the conditions just enumerated predispose to nervous disturbances, such probability does not suffice in itself as a safe augury of the origin of the disease. The most likely and most satisfactory explanation at present is, that when an animal becomes rabid it has contracted the disease from another animal—perhaps of the same species—already affected. It is, so far, conclusive that the saliva upon the teeth is the cause of the mischief. In the rabid animal there is a noticeable loss of vivacity and a constant moping; the temper becomes abnormal—either additionally friendly or extremely snappish and irritable, and the animal is liable, without the slightest warning to fly into paroxysms of rage over the slightest thing. From the first there ensues a depravity of appetite, the most filthy substances being devoured with avidity. Its treatment of members of its own species, too, is remarkable, for without the slightest provocation, it indulges in most angry snaps at them. The ordinary healthy dog progresses with an air of attention to its surroundings that is always evident, but the mad dog is sadly deficient in this particular, and aims ahead with a sullen, heedless air that is only disturbed by the

sight or sound of another of its species, or person endeavouring to obstruct its passage. To continue, mad dogs will often gnaw off their own tails. There is a distinctive howl, too, they have, which is easy of recognition, and a mucus is freely discharged, from the mouth, which increases as the disease advances, and is accompanied by a hanging (semi-paralysis) of the lower jaw. A few days after the initiation of the disease, a very remarkable change in the appearance of the animal is noticeable;—owing to the small quantity of nourishment that has been taken, the animal becomes gaunt and emaciated, the flanks fall in, the eyes dim and become deep set, weakness comes on apace, and the release of death, at or about the sixth day, consummates its sufferings. The symptoms of rabies in dogs are in great measure the same as those of Hydrophobia in man, except that dogs are not afraid of water, they apparently have no cutaneous hyperœsthesia, and, towards the close, there supervenes a paralysis of the lower maxillary and hinder extremities.

I have given much study to the post mortem phenomena of rabies in dogs and cats, with a view to discovering whether or not there are, in this disease,—a disease having, by the way, an intimate relationship with the brain and its processes,—any morbid anatomical appearances that may be recognized as directly due to the disease. Of fourteen induced cases of rabies I observed the following:—

1.—*Dog.*—Post Mortem muscular rigidity. General and extensive pharyngeal, laryngeal, bronchial and œsophageal congestion, particularly the last named. Hyperæmia of the central nervous organs and leucocyte accumulations around capillaries of cerebrum convolutions and basal brain ganglia; the latter were particularly evident around the medulla oblongata, cerebellum, and cord (grey matter).

2.—*Dog.*—Post Mortem muscular rigidity. General

pharyngeal, laryngeal, and bronchial congestion. Slight œsophageal congestion. Extravasation of blood into cord (cervical region). Hyperæmia of the central nervous organs and leucocyte accumulations around vessels and capillaries of cerebrum convolutions, basal brain ganglia, medulla oblongata, and particularly evident around cerebellum and grey matter of cord.

3.—*Cat.*—Post Mortem muscular rigidity. Marked laryngeal, bronchial and œsophageal congestion. Hyperæmia of the central nervous organs. Slight leucocyte accumulations around capillaries of cerebrum convolutions, medulla oblongata, cerebellum, and cord (grey matter). Medulla oblongata and cerebellum showed most leucocytes.

4.—*Dog.*—Post Mortem muscular rigidity. Extreme congestion of the pharynx, larynx and lungs. Complete occlusion of the œsophagus. Hyperæmia of central nervous organs. Large accumulations of leucocytes around basal brain ganglia, medulla oblongata, cerebellum, and cord. Few leucocytes around vessels and capillaries of convolutions (cerebrum). Large extravasation of blood in grey matter of cervicle region of cord.

5.—*Cat.*—Post Mortem muscular rigidity. Marked laryngeal and bronchial, and very marked œsophageal congestion. Hyperæmia of central nervous organs. Large accumulation of leucocytes around cerebellum and medulla oblongata. Smaller accumulations around vessels and capillaries of convolutions of cerebrum.

6.—*Dog.*—Post Mortem muscular rigidity. General pharyngeal, laryngeal, bronchial and œsophageal congestion. Hyperæmia of central nervous organs. Leucocyte accumulations around cerebellum, medulla oblongata, grey matter of cord, and, in lesser quantity, around capillaries of cerebrum convolutions.

7.—*Dog.*—Post Mortem muscular rigidity. Very

swollen tongue. Marked laryngeal and bronchial, and extremely marked œsophageal congestion. Atrophied cerebellum. Hyperæmia as before. Great accumulations of leucocytes around medulla oblongata, cerebellum, and grey matter of cord; also in less degree around cerebrum convolutions.

8.—*Dog*—Post Mortem muscular rigidity except in fore-paws. General pharyngeal, laryngeal, and bronchial congestion. Œsophagus very congested and papillated. Hyperæmia as before. Leucocytes congregated sparsely around cerebrum convolutions but thickly around cerebellum, and in lesser quantities around medulla oblongata, and grey matter of cord, and basal brain ganglia.

9.—*Cat.*—Post Mortem muscular rigidity except lower maxillary. General laryngeal, bronchial and œsophageal congestion. Atrophied cerebellum. Hyperæmia as before. Leucocytes abundant around cerebellum. Also in less quantities around medulla oblongata and grey matter of cord. Unable to find any around vessels and capillaries of cerebrum convolutions.

10.—*Dog.*—Post Mortem muscular rigidity. Exceptional congestion of entire œsophagus. Marked congestion of pharynx, larynx, and lungs. Atrophied cerebellum. Extravasation of blood in grey matter of cord (dorsal and cervical regions). Leucocytes in abundance around grey matter of cord and cerebellum, in small quantities around medulla oblongata, and absent around cerebrum vessels and capillaries of convolutions. Extravasation of leucocytes into mucous membrane of kidneys.

11.—*Dog.*—Post Mortem muscular rigidity. Swollen tongue, numerous sub-lingual vesicles. General pharyngeal, laryngeal and lung congestion. Œsophagus congested and occluded with fæces. Hyperæmia as before. Leucocytes in abundance around cerebellum (dis-

coloured). Also leucocytes in less quantities around vessels and capillaries of cerebrum convolutions, basal brain ganglia, medulla oblongata, and grey matter of cord.

12.—*Dog.*—Post Mortem muscular rigidity. Sub-lingual vesicles. Swollen tongue. Slightly congested pharynx and larynx. Marked lung congestion. Extreme œsophageal congestion. Atrophied and discoloured cerebellum. Leucocyte accumulations around cerebellum and medulla oblongata, also sparsely around grey matter of cord.

13.—*Fox.*—Post Mortem muscular rigidity. Numerous sub-lingual vesicles. General lung congestion but only slight. Œsophagus considerably congested. The cerebellum was discoloured and distended with serous fluid; Leucocytes in abundance were around it and in small quantities were found around grey matter of cord and medulla oblongata. Leucocytes were in the mucous membrane of kidneys, too.

14.—*Dog.*—Post Mortem muscular rigidity. General and marked pharyngeal, laryngeal, bronchial and œsophageal congestion, nares occluded with fæces. Swollen tongue, with numerous vesicles beneath. Cerebellum atrophy and discolouration. Leucocyte accumulations around the cerebellum, grey matter of brain, medulla oblongata, basal brain ganglia, and vessels and capillaries of cerebrum convolutions.

Before entering upon any explanation of the post mortem phenomena presented by the Cerebellum of an Epileptic, it is necessary to have a proper understanding of what Epilepsy really is, and, too, some insight into the causes of it, though at best it must be confessed the causes are most obscure. Both Definition and Causation are exceedingly difficult to determine. Epilepsy (Morbus comitialis vel sacer) is a functional derangement of the nervous centres characterized at irregular intervals by sudden temporary

seizures attended with physical, or mental, or both physical and mental disturbances. There are many varieties of epilepsy;—in some, the mental phenomenon may be entire loss of consciousness, or it may be partial; the physical phenomena may vary in intensity from severe to mild tonic and chronic convulsions. Still, however slight an attack may be, there are always potentially present the whole of the foregoing phenomena. Principal among the reputed causes of the disease is self-pollution or masturbation, and it may be safely opined that this and venereal excesses are the most especial and most frequent. A certain amount of importance must be attached to purely emotional causes, such as fright, disappointment, grief and anxiety, but it is probable that emotional disturbances are contributory to rather than directly causative of Epileptic attacks, and careful investigation strengthens one's conviction that sexual predisposition has usually been present in such cases, and manifestation been induced or precipitated by the emotional disturbances rather than originated by them. Alcoholism and the much drinking of absinthe most certainly are causative of epileptic conditions. The blight and curse of hereditary taint is universally recognized as exerting a most extensive and lamentable predisposition to this affection, not only true Epilepsy being provocative of the dread taint but also such neurotic allies of Epilepsy as hysteria, insanity, &c. It is interesting to note that in affected families, the diseased mental condition frequently differs in its nature, in one member evidencing itself as chorea, in another as true Epilepsy, in another as partial intellectual derangement, in another as complete idiocy, and so on. Referring to cranial shape in regard to true Epilepsy, it cannot be said that there is an Epileptic skull, that is to say, a skull showing externally any evidences of the diseased condition within it. The location of the lesions will be presently considered.

Of course, although so many instances of Epilepsy are known to be hereditary, predisposition to Epilepsy may be acquired. Children, after fevers or convulsions incidental to teething not infrequently developing the disease afterwards. Adults, with apparently no family history of the disorder, instancing the disease in a most fearful manner after prolonged personal excesses,—those people of strong mental-motive temperament being the most frequent sufferers. Sex seems to make little if any difference to liability, and there are probably almost as many women as men who are subject to the disease. In those cases that I have personally investigated, the number of women who have been the victims of hereditary predisposition have vastly preponderated over those of men. I have seldom seen an instance of acquired predisposition in women, but have known many male sufferers. In brief, experience of cases leads me to presume that woman principally suffers as the victim of heredity, man as both the victim of heredity and of acquired predisposition. The periods of life when attacks usually manifest themselves are;—just previous to, during, and immediately succeeding puberty,—that is to say between the eleventh and eighteenth years,—and after the fortieth year; and, in women, especially at the change of life. These particular times bear an intimate relationship to the disease, and, as will presently be shown, the occurrence of these attacks at these interesting physiological-change periods is something other than simply a co-incidence. The periods just mentioned are those in which a vast majority of Epileptic and Epileptiform attacks occur; however, attacks do occur at other times, but comparatively seldom, and when they do so, are usually the results of acute emotional or physical qualification. I have never known a case of primary Epilepsy after the age of fifty-two.

A typical Epileptic fit comes on suddenly and

unexpectedly and is usually preceded by a prodromal period; the sufferer utters a short cry, loses consciousness and all control, and falls helplessly to the ground in the direction to which his body inclined previous to the loss of consciousness; as the muscles become rigid at one or both sides of the body, the fall is usually either on the head directly forwards or backwards; the muscles then almost imperceptibly contract and respiration stops. This Primary condition is maintained during an interval of a few seconds and then the Secondary stage is reached;—whilst the patient is still in a state of unconsciousness, respiration begins, the body undergoes clonic unilateral spasms and its surface becomes livid, whilst the veins of the head and neck become distended and the tongue is bitten—sometimes very severely. The Tertiary stage supervenes at the end of a couple of minutes; the convulsions cease, and the peculiar bodily colour becomes modified, though insensibility still continues: after a time though, recovery is either rapid and complete, or delayed by states of stupor or mania.

I have spoken of a prodromal period. This period is not always present,—that is to say, it is not present with all persons. The probability, however, is that a prodromal period present before one attack is also present before succeeding attacks. Prodromal signs are of varied significance; in some instances being so slight as to be alone apparent to the relations or friends of the patient; in others being so well marked as to readily ensure detection and give timely warning. The latter signs are those of aberration or abnormality of intellect, unusual behaviour and the exercise of demonstrations of feeling quite different to those ordinarily shown; perhaps the mind become vacant, dull and listless, and the disposition morose and vengeful; or perhaps the general behaviour and speech become surprisingly exalted, lively, and inordinately exaggerated; perhaps the patient may be possessed by maniacal fury,—

his eye gleaming stonily and madly, and, perhaps, the fingers twitching spasmodically. It is difficult to tabulate the whole of the prodromal phenomena exhibited by different epileptics. The most characteristic and therefore most easily recognizable premonitory symptoms are those that are not shown until very shortly before the onset of the Primary attack ; any one, any group, or all of the senses may be involved ; any one or any group of the bodily muscles may be involved ; any one or any group of the intellectual faculties may be involved. The patient may apparently hear strange noises, have strange and weird and diabolical visions, smell objectionable odours, taste offensive matters, or feel extending sensations (epileptic aura) of cold, heat or pain ; the patient may be seized with retching, suffer from spasmic muscular contraction or tremor of some muscle or muscles of the head, neck, body or limbs. The culmination of whatever premonitions there are present is the Primary stage of the attack. It should be remembered by the reader that the memory of the patient after the attack is often unable to recall the kind of premonition that asserted itself, and the more severe in its nature the premonition, the more profound is the ignorance of the patient of its onset. It may be safely said that practically every patient who manifests any inordinate premonitory sign never afterwards remembers it. In those few cases when a patient has been able to recall certain acts done by him or her during this unbalanced stage, it is highly probable that the reason he or she has been able to do so is to be attributed either to some temporary healthy exercise of the faculties at the time, or to the fact that the remembered action was due to the general idiosyncrasy of the individual rather than the diseased condition of the brain.

The most consistent feature of the Primary stage of an epileptic fit is the completeness and suddenness of the unconsciousness induced. Cases have been recorded

where there has been *no* unconsciousness, but I have never seen an instance of such. All the senses are oblivious to the stimuli at our command. The tonic convulsions and unilateral muscular contractions (for they generally are unilateral) are such, that the more powerful the muscles, the more pronounced their supremacy over the weaker ones that antagonize with them. The hideousness of face distortion is extreme, and the bodily contortions are often of the most curious shapes. The epileptic cry, which is due no doubt, when uttered, to laryngeal muscular spasm previous to fixation, is strange and distressing, its tone depending upon the predominating vocal register of the individual. The Primary epileptic attack is a horrifying spectacle;—the dilated eye-pupils insensible to the action of light, the persistent death-coloured skin, which, when it changes at all, but gradually merges into a turgid, red state; the feeble pulse-beat,—all conspire during the half-minute or so of their presence to fill the onlooker with an inexpressible sense of wonder and dread. The Secondary stage is none the less awe-inspiring, perhaps it is more so;—the livid, bloated venous-distended face and neck, slowly subsiding during the continuance of the stage; the lapsed tonic spasms replaced by clonic spasms—alternating unilateral flexor and extensor contractions; the oscillating eye-pupils; the violent movement of the facial muscles; the violent opening and shutting of the mouth seizing the protruding tongue between the teeth and lacerating it with remorseless force; the convulsed bodily muscular movements; the involuntary discharge of urine, and activity of the bowels; the escape of blood-stained mucus from the mouth; the clammy skin with its free perspiration; the violent heart beats;—all form a series of phenomena painful to the most inured beholder to witness. At the end of a few minutes, or perhaps a few seconds, the sufferer gives forth a deep sigh and the Tertiary stage is approached. This Tertiary stage varies considerably. In some cases

recovery is instant; in others a deep coma ensues and from which one's efforts are futile to rouse. When consciousness returns, it does so slowly, the patient indulging in incoherent talk, reeling like a drunken man in attempts to walk, and acting in various maniacal ways. In every case there is a resulting weariness and mental and emotional absence of equilibrium. The above sequence is typical of epilepsia gravior. Epilepsia mitior, and other terms applied to modifications and minor or incomplete fits, it is hardly necessary to describe. In respect to number, one attack is generally succeeded by others, but the first epileptic attack has, at times, been the last, or has been reputed to be. Speaking of epilepsia gravior, I have never heard of an instance where one attack has been the first and last when a person has lived some considerable time after the initial fit. In subsidiary forms of phenomena that have been classed under the heading of Epilepsy, isolated instances of fits are known to occur, but it is highly probable that such are caused by temporary functional disturbance or partial impairment than by immediate brain disease. The frequency and virulence of attacks are dependent upon the brain-poise and the brain health, and only on the bodily health when the bodily members or organs have a direct qualifying influence upon the brain state,—and only one bodily organ has that to a great degree.

In those liable to fits, attacks are usually visitant after any extraordinary excess or mental disturbance. I should deem the menstruation process a provocative of mental disturbance—if severe, and parturition a provocative also, under the same circumstances.

The condition of a patient in the intervals between seizures is a point of much interest. One would naturally expect that, in a case of brain disease, there would be, at any rate, some symptom or symptoms of interference with nervous balance that would become recognizable. In many cases there is some difficulty in

specifying where any such symptom may be present, but, on the other hand, in the average number there are generally some peculiarities that are conspicuously evident, especially loss of memory, incapacity of concentration and dulness of apprehension; of these, loss of memory is the most frequent. But there are, too, sudden extremes of temper, fidgettiness, and depression of spirits.

The term Epileptic Mania embraces within it the most remarkable mental phenomena associated with epileptic conditions, the attacks resembling those of an epileptic paroxysm, but often occurring unaccompanied by a fit, and lasting for minutes, hours, days, or even weeks. The suddenness of their onset is only equalled by their suddenness of subsidence. The varieties of this condition are two;—haut mal and petit mal. In haut mal the patient is wild and ungovernable, haunted by awful hallucinations, prompted by the most erotic ideas, and imbued with a wholesale suspicion of every one. In petit mal there is profound pessimism, despondency, distrust, and fear; the subject seems to be quite oblivious to a sense of responsibility, and the slightest incentive—imaginary or real—prompts to a degree of passion that does not hesitate at murder or self-destruction. In both haut mal and petit mal there is, apparently, coherence, but of real coherence there is little and any remembrance of revengeful actions or ordinary behaviour is only fragmentary and hazy. Petit mal not seldom degenerates into a chronic imbecility.

Judging from statistics, Epilepsy does not appear to shorten life, though, of course, it increases its risks. Apoplectic attacks are epileptiform.

The pathology of this disease has been, for a very long time, most obscure. The difficulties that present themselves in its determination are so many and so—apparently—insurmountable, that the hope that they will be eventually overcome seems to be very faint.

An important fact in connection with the disease is that post mortem conditions have to be considered as alternatives,—either as provocatives to or results of diseased processes. Through the kindness of many surgeons I have been enabled to avail myself, upon many occasions, of opportunities of dissection and microscopical examination of the brains of deceased Epileptics.

In the first place, there is a difference between the appearance of an ordinary healthy brain and that of a subject to Epilepsy, but it is a difference that the student who has made but few brain examinations might easily fail in detecting, whereas a somewhat extensive acquaintance with post mortem brain dissection would obviate the likelihood of any mistake. This is particularly so of brains of sufferers from chronic Epilepsy. It has been said that certain brain parts (epileptic) have often been found considerably atrophied,—I have never found this so, except as a characteristic of epileptics who have had a history of free alcoholic indulgence, and I attribute the atrophy directly to the alcoholic action. It is worthy of remembrance, too, that induration of the white brain matter is a common accompaniment to the general substance shrinkage that alcohol induces, and, inasmuch as one finds no induration in the brains of epileptics who have not been participants of ardent spirits to any extent, I am not disposed to designate induration as directly, or indirectly the result of Epilepsy. As far as condition of the brain is concerned, before the death of the patient, I know no reason to doubt that, in the same way as the general body, the brain may be successively anæmic and congested during a paroxysm; but such conditions, if present, are results of the action of the already present lesions rather than conditions inducing such lesions, or even contributing to them. The sequence I adopt is that of functional lesions setting up disorganized conditions in the brain,

and these conditions producing the physical phenomena. Anæmia of the brain is the result of functional disorder rather than physiological incapacity or disease. The most careful investigations and painstaking microscopy unmistakably reveal evidences that the Cerebellum, medulla oblongata and the corpora striata are not normal in the Epileptic brain. Theoretically, it is probable that the motor tract is concerned in the convulsive manifestations of Epilepsy, but as such convulsions are not always characteristic of cases, its implication must be one of extension. I look upon the shrinkage I have before referred to, and, which sometimes is noticeable in epileptic brains, as of no help in determination of the disease condition; nor do I consider the very occasional presence of hemorrhage in the thickened perivascular environs of the vessels, of help. As a matter of fact, the Epileptic brain has, as a rule, the appearance of health. I might here add that I believe that death when it occurs during a fit is directly due to the capillary hemorrhages. My reason for this is that, in my own researches, I have never found this capillary hemorrhage evidenced in the brains of any Epileptics who have died a natural death. I have found it in two cases where death ensued during an attack. We know that induced anæmia causes Epileptiform movements that are as truly convulsions as those of Epilepsy itself, but my contention is that what one is pleased to term brain anæmia cannot be said to occur in the ordinary course of everyday life, and it must therefore be a condition that is the result of some other brain derangement which must have preceded it. In other words, anæmia is a consequence and not a cause.

We are forced more and more to the conclusion that the cord is pre-eminently a conductor of brain governance, not the originator of governance. The office it serves in epilepsy is evidently this, hence, because section of a lateral column of it above the

tenth vertebra causes convulsions, is because the connection of the moving parts and brain that governs them is interfered with, (there being no question that the brain, which dominates movement, also maintains poise or equilibrium) and, such being severed, there follow reflexes of the bodily parts implicated.

It has been because I was fully persuaded that the initial phenomenon of Epilepsy was due to some special and limited spot in the nervous system, that I have mainly directed my observations to the detection if possible of any abnormality in any of the nervous centres. If such a spot were capable of recognition, it seemed to me that the whole of the after phenomena of the disease might be accounted for in the reasonable assumption, that, from some physical or mental qualification, a sudden influence might be propelled therefrom, which would, by implication of the motorial system and sensorium, cause perversion and annulment of motive action and extinction of consciousness.

As has been fully explained in my "Diseases of the Nervous System", I have discovered that the Cerebella of Epileptics who have died during attacks, manifest a peculiar sponginess of consistency at a particular cerebellum spot close to the Vermiform Process, left or right. My attention was first directed to it because of the absence of any signs there of the congestion that, in each case, surrounded it. Close observation revealed the fact that the entire composition of the part seemed annihilated as far as its constitution and connection with the surrounding parts was concerned,—the appearance of the disorganized portion resembling an aggregation of dust more than anything else. Upon reference to my brain specimens of chronic epileptics, I found that, except for the entire absence of any signs of congestion, there, nevertheless, was present this curious area,—an area differing in depth and extension, and differing, too, slightly in location; but an area not at all discoverable, nor any

analagous conditions, in the same locality of the cerebella of brains with no epileptic history. That the area I have referred to is the one we are fully capacitated to denominate the original lesion of epilepsy, is justified from the evidences of a contrast of twenty-one epileptic brains with twenty-eight non-epileptic.

The question of treatment is not within the province of this work, but the fact that fresh possibilities of antagonizing and modifying this dire disease exist, is a strong encouragement to perseverance.

Experimenting upon living animals runs directly counter to human nature and is strongly to be reprehended when practised by the merely curious or by any except as supplementary to a profound and thoroughly conscientious study of all the evidences at hand. It has been questioned whether experiments upon living subjects are ever justifiable and whether the scientific deductions obtained thereby sufficiently remunerate the scientist. They should never be made unless with a very definite purpose in view, and then only when deemed absolutely essential to demonstrate a truth. No attempt need here be made to detail the numerous difficulties that surround the experimenter or the time, labour, patience and expense involved. It must suffice that the latter array in itself is appalling to any but the most enthusiastic or most curious. There is a too current belief that experimenting upon living animals is the most satisfactory method of prosecuting inquiry. In those personal experiments that have not been necessitated by diseased conditions, I have scrupulously endeavoured to avoid complicating the issues of such by performing only those operations that I have been enabled to clearly persuade myself have been necessitated. The process of reasoning, distinct from demonstration upon the living has certainly warranted the Phrenological definition of cerebellum function. The strongest and apparently most tenable

objections to this definition have evolved as the result of experiments upon living animals, and the confirmation or refutation of these objections have been the points round which these experiments have concentred. Humanitarianism has been so far justified in its contention against vivisection, for I fail to see what vivisection has truly disproved respecting the before-mentioned definition. Vivisection has been credited too much, yea, far too much, with possibilities of vital and important revelations, but I must say—and I am here speaking purely of experimental vivisection of the healthy subject—that I have throughout been constrained, that, strange indeed must be the dispensations of a Providence that necessitates cruelty and torture ere truths are capable of demonstration. The world must never descend to discredit the higher instinctive feelings, or be encouraged to act contrary to them. I do not believe that Phrenologists advocate general vivisection, recourse to it has been thrust upon them. Personally—and I have probably experimented more extensively than any one advocating the general principle of Phrenology—the knowledge of vindication of principle is not undimmed by the remembrance of suffering none the less regrettable because minimised to the utmost of my ability.

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